Magnetic High-Field Phases of Magnetoelectric LiNiPO4

Fogh, Ellen; Toft-Petersen, R.; Nojiri, H.; Granroth, G.; Kihara, T.; Christensen, Niels Bech

Publication date:
2014

Document Version
Publisher's PDF, also known as Version of record

Magnetic High-Field Phases of Magnetoelectric $LiNiPO_4$

E. Fogh [1], R. Toft-Petersen [2], H. Nojiri [3], G. Granroth [4], T. Kihara [3] and N. B. Christensen [1]

[1] Department of Physics, Technical University of Denmark, Kongens Lyngby, Denmark
[2] Helmholtz Zentrum Berlin für Materialen und Energie, Berlin-Wannsee, Germany
[3] Institute for Material Research, Tohoku University, Sendai, Japan
[4] Neutron Scattering Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennesee

In this work the magnetic high-field phases and magnetoelectric properties of $LiNiPO_4$ are studied up to 30T.

$LiNiPO_4$ is a member of the family of lithium orthophosphates which are of orthorhombic structure and exhibit the magnetoelectric effect [1]. $LiNiPO_4$ is a quasi-2D system with long range antiferromagnetic order below T_N=21.8T in zero-field. The magnetic phase diagram of the material has previously been studied up to 17.3T [2,3] and pulsed-field magnetization measurements up to 23T show several additional phase transitions [4].

Here $LiNiPO_4$ is investigated for fields up to 30T by pulsed high magnetic field time-of-flight Laue neutron diffraction and by magnetization and electric polarization measurements. Two high-field phases were found in agreement with the previous observations. The ordering vectors were determined and possible spin structures were suggested. The polarization measurements show a re-entrance of the magnetoelectric effect for $\mu_0 H \approx 19-21$T, which points towards a commensurate ferrimagnetic state. However, the behavior of the effect is not fully understood. The effect vanishes above 21T where either a linearly polarized spin structure or a spin spiral is present.

The experimental technique using pulsed high magnetic fields in connection with neutrons is relatively new [5]. Nevertheless, the results displayed here show that the technique presents a future possibility to study high-field phases of certain magnetic materials.

References

[1] M. Mercier, J. Gareyt, and E. F. Bertaut, C. R. Acad. Sci. Ser. B 264, 979, 1967
[2] T. B. S. Jensen, N. B. Christensen, M. Kenzelmann, H. M. Rønnow, C. Niedermayer, N. H. Andersen, K. Lefmann, J. Schefer, M. Zimmermann, J. Li, J. L. Zarestky, and D. Vaknin, Phys. Rev. B, 79(092412), 2009
[3] R. Toft-Petersen, J. Jensen, T. B. S. Jensen, N. H. Andersen, N. B. Christensen, C. Niedermayer, M. Kenzelmann, M. Skoulatos, M. D. Le, K. Lefmann, S. R. Hansen, J. Li, J. L. Zarestky, and D. Vaknin, Phys. Rev. B, 84(054408), 2011
[4] V.M. Khrustalyov, V.N. Savitsky, and N.F. Kharchenko, Czechoslovak Journal of Physics, 54, 2004
[5] S. Yoshii, K. Ohoyama, K. Kurosawa, H. Nojiri, M. Matsuda, P. Frings, F. Duc, B. Vignolle, G. L. J. A. Rikken, L.-P. Regnault, S. Michimura, and F. Iga, Phys. Rev. Letters, 103(077203), 2009